



IRUH33PA13B20K

ELDRS Test Report

FEBRUARY 2006

Revision A

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INTRODUCTION

This test report covers the total ionizing dose tests performed on the IRUH33PA13B20K Adjustable Low Dropout linear regulator in a hermetic package. The ELDRS test was performed on ten samples of the device from production lot H903185, which had completed MIL-PRF-38534 "H" level assembly and screening. On January 19, 2006 International Rectifier tested this device for ELDRS hardness at the University of Massachusetts, Nuclear Research Facility using their CO⁶⁰ source.

SUMMARY OF RESULTS

All of the test samples passed the post radiation test requirements for total ionizing dose levels up to 44.6K RAD(Si). The results show more degradation on the off-bias devices for all tests parameters as a function of radiation. The "ON" biased samples passed the post radiation test requirements for all of the required dose levels.

TEST METHOD

The test method used as a guide in the development of the Test Plan was MIL-STD-883, Method 1019 Ionizing Radiation, Condition C. This method establishes the basic requirements for the performance and execution of the tests.

TEST PLAN

The samples were exposed to CO⁶⁰ irradiation in both an "ON" and "OFF" biased state per the requirements of the test plan and the radiation test specification. Post radiation testing of the devices occurred at the UMass facility after each dose step was complete. The devices were tested starting on January 20, 2006 for post radiation effects for dose levels up to 100K Rad(Si) at a dose rate of 0.065 Rad(Si)/sec.

ON Biased serial numbers: 111, 114, 89, 67, 96
OFF Biased serial numbers: 94, 93, 85, 117, 76
Control Samples: 71 and 107.

The Radiation Test Specification is included in Appendix B. The testing occurred in the following manner:

1.0 Purpose

The purpose of this test is to characterize and qualify the ELDRS effects for International Rectifier's hybrid low dropout regulator devices. The data resulting from the tests may be incorporated in the IR data sheet for the product.

2.0 Test Responsibility

International Rectifier shall be responsible for conducting the tests, which shall be performed at the University of Massachusetts Research Reactor facility. International Rectifier shall be responsible for the final Test Report.

3.0 Test Facility

3.1 Nuclear Reactor

The University of Massachusetts Research Reactor shall be used to provide the source for Gamma radiation. UMRR will also provide information on dose rate, total dose, irradiation test times and dosimetry for this evaluation.

3.2 Test Equipment

The necessary test equipment including interface board, cables, power supplies, measurement system, etc. shall be provided by International Rectifier.

3.3 Sample Size

Sample size shall be determined based on device type, characterization parameters. As a minimum, the sample size shall meet the requirements of Mil- PRF-38534. Sample size for this TID evaluation equals 12 devices. Five of the samples shall be biased with the worst-case input voltage of 6.8 volts and five samples shall be biased "in-circuit" with the power supply turned off. Two samples shall be maintained as controls of which one shall be tested at each dose step.

4.0 Test Devices

4.1 The following device is planned for Total Ionizing Dose characterization:

- a. IRUH33PA13B20K

4.2 All devices shall be subjected to a minimum of 160hrs of burn-in and electrically tested over the entire operating range prior to radiation exposure.

4.3 All devices shall be tested after each radiation exposure per T090104G within 1 hour and placed back on to radiation exposure within 2 hours.

5.0 Test Method

MIL-STD-883, Method 1019 Condition C shall be used to establish the procedure for all testing described herein.

6.0 Record Keeping

The Reactor facility shall provide dosimetry data for the CO⁶⁰ source. Each exposure run shall be cataloged with the appropriate number in order to maintain correlation to the appropriate data set. IR will be responsible for collecting and compiling the test data.

7.0 Test Report

The Test Report shall include the following information:

- a. Device type(s), serial numbers, wafer lot identification (per active component)
- b. Test dates
- c. Facility, source type
- d. Bias conditions
- e. Comments and observations
- f. Pre and Post Electrical data
- g. Summary descriptive including graphs (if applicable)

TEST FACILITY

The University of Massachusetts, Lowell, Nuclear Research Reactor is a 1 Mega-Watt, Uranium²³⁵ enhanced core reactor. The UMass Lowell Radiation Laboratory provides controlled radiation environments and analytical measurement services to government organizations and to industry. The laboratory provides facilities for proton, neutron, and gamma environments. The Gamma Cave is an irradiation room inside this facility having an equi-dimensional volume of 512 cubic feet. A wide range of dose rates, 1Gray (100 rad) per hour to 10,000 Gray (1 Mrad) per hour, is available. Several small ports penetrate one shielding wall to provide access for instrumentation cables.

Test Results

The key pre and post radiation test results are shown in Tables 1 thru 10. In Figures 1-6, the parametric shifts are shown graphically for all exposed devices. The raw test data for all the parameters tested is shown in Appendix A. As outlined in the Test Plan, five of the devices exposed to total ionizing dose irradiation were biased “ON” with the maximum input voltage and five samples were placed in the bias circuit with the power supply off or biased “OFF”. All samples passed the post radiation test requirements up to 44.6K RAD(Si). The parameters affected the most by the ionizing radiation were Output Voltage, Ripple Rejection, and Shutdown Threshold Voltage with the worst-case condition being the “OFF” bias.

The output voltage shift over radiation exposure with a 1.5A load current was +6.2% for the “OFF” biased samples and + 3.7% for the “ON” biased samples after exposure 100K RAD(Si). The shift at 44.6K RAD(Si) exposure was +4.7% for the “OFF” biased samples and + 3.2% for the “ON” biased samples.

Table 1 “ON” Biased Samples, VOUT, VIN=3.3V @1.5A

T#1	VOUT							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	2.510	2.510	2.505	2.508	2.509	2.375	2.625	V
107	2.494	2.495	2.495	2.493	2.492	2.375	2.625	V
111	2.497	2.510	2.545	2.572	2.587	2.375	2.625	V
114	2.509	2.520	2.550	2.579	2.595	2.375	2.625	V
89	2.506	2.520	2.554	2.588	2.601	2.375	2.625	V
67	2.503	2.515	2.549	2.580	2.597	2.375	2.625	V
96	2.506	2.524	2.566	2.588	2.602	2.375	2.625	V
Min	2.497	2.510	2.545	2.572	2.587	2.375	2.625	V
Avg	2.504	2.518	2.553	2.581	2.596	2.375	2.625	V
Max	2.509	2.524	2.566	2.588	2.602	2.375	2.625	V

Table 2 “OFF” Biased Samples, VOUT, VIN=3.3V @1.5A

T#1	VOUT							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	2.510	2.510	2.505	2.508	2.509	2.375	2.625	V
107	2.494	2.495	2.495	2.493	2.492	2.375	2.625	V
94	2.505	2.516	2.569	2.608	2.665	2.375	2.625	V
93	2.499	2.517	2.563	2.610	2.655	2.375	2.625	V
85	2.500	2.514	2.561	2.604	2.651	2.375	2.625	V
117	2.510	2.529	2.570	2.612	2.661	2.375	2.625	V
76	2.499	2.515	2.556	2.600	2.651	2.375	2.625	V
Min	2.499	2.514	2.556	2.600	2.651	2.375	2.625	V
Avg	2.503	2.518	2.564	2.607	2.657	2.375	2.625	V
Max	2.510	2.529	2.570	2.612	2.665	2.375	2.625	V

Table 3 “ON” Biased Samples, VDROD, IOU=3A

T#8	VDROD							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	0.20	0.20	0.19	0.19	0.20	0	0.4	V
107	0.19	0.19	0.19	0.19	0.19	0	0.4	V
111	0.20	0.21	0.22	0.23	0.24	0	0.4	V
114	0.20	0.21	0.22	0.23	0.24	0	0.4	V
89	0.19	0.20	0.22	0.23	0.24	0	0.4	V
67	0.19	0.21	0.22	0.23	0.25	0	0.4	V
96	0.20	0.20	0.22	0.23	0.25	0	0.4	V
Min	0.192	0.197	0.215	0.227	0.239	0	0.4	V
Avg	0.195	0.206	0.217	0.231	0.244	0	0.4	V
Max	0.199	0.212	0.219	0.234	0.250	0	0.4	V

Table 4 “OFF” Biased Samples, VDROD, IOU=3A

T#8	VDROD							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	0.20	0.20	0.19	0.19	0.20	0	0.4	V
107	0.19	0.19	0.19	0.19	0.19	0	0.4	V
94	0.20	0.20	0.22	0.22	0.25	0	0.4	V
93	0.19	0.20	0.22	0.23	0.25	0	0.4	V
85	0.21	0.22	0.23	0.25	0.23	0	0.4	V
117	0.20	0.22	0.22	0.24	0.27	0	0.4	V
76	0.20	0.21	0.22	0.24	0.25	0	0.4	V
Min	0.192	0.204	0.215	0.223	0.232	0	0.4	V
Avg	0.199	0.212	0.222	0.237	0.252	0	0.4	V
Max	0.210	0.223	0.230	0.249	0.265	0	0.4	V

Table 5 “ON” Biased Samples, CURRENT LIMIT, VIN=3.3

T#9	CURRENT LIMIT							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	9.2	9.2	9.2	9.1	8.9	3	10	A
107	8.9	9.2	9.3	9.1	9.1	3	10	A
111	8.8	9.1	9.3	9.1	8.8	3	10	A
114	8.8	9.1	9.3	8.9	8.9	3	10	A
89	8.8	9.1	9.3	9.1	8.9	3	10	A
67	9.1	9.0	8.9	8.9	8.5	3	10	A
96	8.9	8.8	9.1	9.1	8.8	3	10	A
Min	8.795	8.845	8.935	8.868	8.511	3	10	A
Avg	8.890	9.026	9.161	8.986	8.783	3	10	A
Max	9.112	9.117	9.252	9.095	8.874	3	10	A

Table 6 “OFF” Biased Samples, CURRENT LIMIT, VIN=3.3

T#9	CURRENT LIMIT							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	9.2	9.2	9.2	9.1	8.9	3	10	A
107	8.9	9.2	9.3	9.1	9.1	3	10	A
94	8.7	8.8	8.8	9.1	9.1	3	10	A
93	8.7	8.8	9.1	9.5	8.8	3	10	A
85	8.5	8.5	8.8	8.5	8.5	3	10	A
117	8.9	9.1	9.1	9.1	8.9	3	10	A
76	8.5	9.1	9.1	9.1	8.9	3	10	A
Min	8.477	8.481	8.798	8.505	8.511	3	10	A
Avg	8.649	8.861	8.980	9.040	8.838	3	10	A
Max	8.885	9.117	9.116	9.459	9.101	3	10	A

Table 7 “ON” Biased Samples, RIPPLE REJECTION = 120Hz.

T#10	RIPPLE REJECTION							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	97.2	97.2	99.2	99.2	98.2	40	200	dB
107	98.2	98.1	98.2	99.2	99.8	40	200	dB
111	98.6	100.4	98.6	89.5	61.9	40	200	dB
114	97.6	99.2	100.4	91.8	61.9	40	200	dB
89	99.8	100.5	98.7	89.5	60.7	40	200	dB
67	100.4	101.2	99.2	89.6	60.8	40	200	dB
96	97.6	99.8	101.1	89.5	61.9	40	200	dB
Min	97.600	99.230	98.630	89.450	60.740	40	200	dB
Avg	98.810	100.224	99.590	89.970	61.460	40	200	dB
Max	100.400	101.200	101.100	91.820	61.940	40	200	dB

Table 8 “OFF” Biased Samples, RIPPLE REJECTION = 120Hz

T#10	RIPPLE REJECTION							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	97.2	97.2	99.2	99.2	98.2	40	200	dB
107	98.2	98.1	98.2	99.2	99.8	40	200	dB
94	98.1	99.8	95.1	63.3	58.0	40	200	dB
93	99.2	99.2	96.3	64.9	59.7	40	200	dB
85	98.1	100.5	95.9	61.9	59.7	40	200	dB
117	98.1	99.2	95.5	64.8	59.7	40	200	dB
76	99.7	98.6	95.9	64.9	59.7	40	200	dB
Min	98.060	98.630	95.110	61.900	58.020	40	200	dB
Avg	98.622	99.468	95.744	63.946	59.370	40	200	dB
Max	99.740	100.500	96.310	64.860	59.720	40	200	dB

Table 9 “ON” Biased Samples, VOLTAGE SHUTDOWN

T#11	VSHDN							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	1.38	1.38	1.37	1.35	1.36	1	1.7	V
107	1.32	1.34	1.31	1.35	1.36	1	1.7	V
111	1.34	1.36	1.45	1.51	1.53	1	1.7	V
114	1.36	1.38	1.45	1.47	1.53	1	1.7	V
89	1.36	1.38	1.45	1.51	1.53	1	1.7	V
67	1.32	1.34	1.43	1.45	1.51	1	1.7	V
96	1.34	1.38	1.51	1.53	1.55	1	1.7	V
Min	1.319	1.338	1.432	1.447	1.507	1	1.7	V
Avg	1.344	1.367	1.459	1.493	1.527	1	1.7	V
Max	1.360	1.380	1.505	1.530	1.548	1	1.7	V

Table 10 “OFF” Biased Samples, VOLTAGE SHUTDOWN

T#11	VSHDN							
Serial #	KRAD LEVEL					Limits		U/M
	0	6	22	45	100	Min	Max	
71	1.38	1.38	1.37	1.35	1.36	1	1.7	V
107	1.32	1.34	1.31	1.35	1.36	1	1.7	V
94	1.32	1.38	1.47	1.50	1.47	1	1.7	V
93	1.34	1.34	1.45	1.49	1.47	1	1.7	V
85	1.32	1.36	1.43	1.47	1.44	1	1.7	V
117	1.34	1.40	1.47	1.49	1.47	1	1.7	V
76	1.32	1.36	1.41	1.45	1.44	1	1.7	V
Min	1.319	1.338	1.411	1.447	1.444	1	1.7	V
Avg	1.327	1.367	1.449	1.478	1.457	1	1.7	V
Max	1.339	1.401	1.474	1.499	1.465	1	1.7	V

Parametric Shifts as a Function of ELDRS Radiation

Figure 1

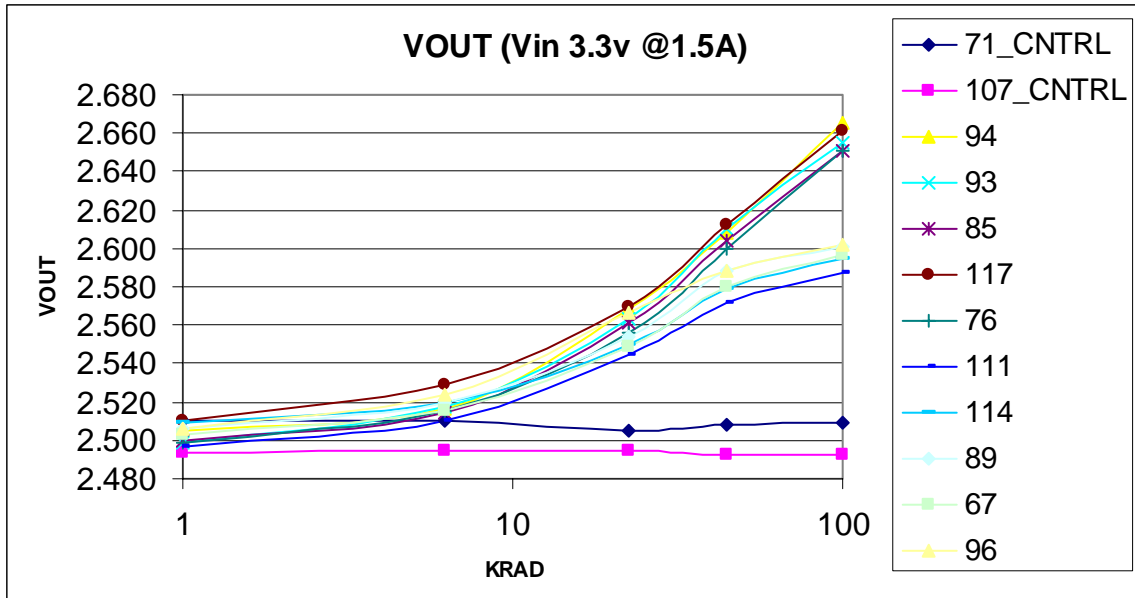


Figure 2

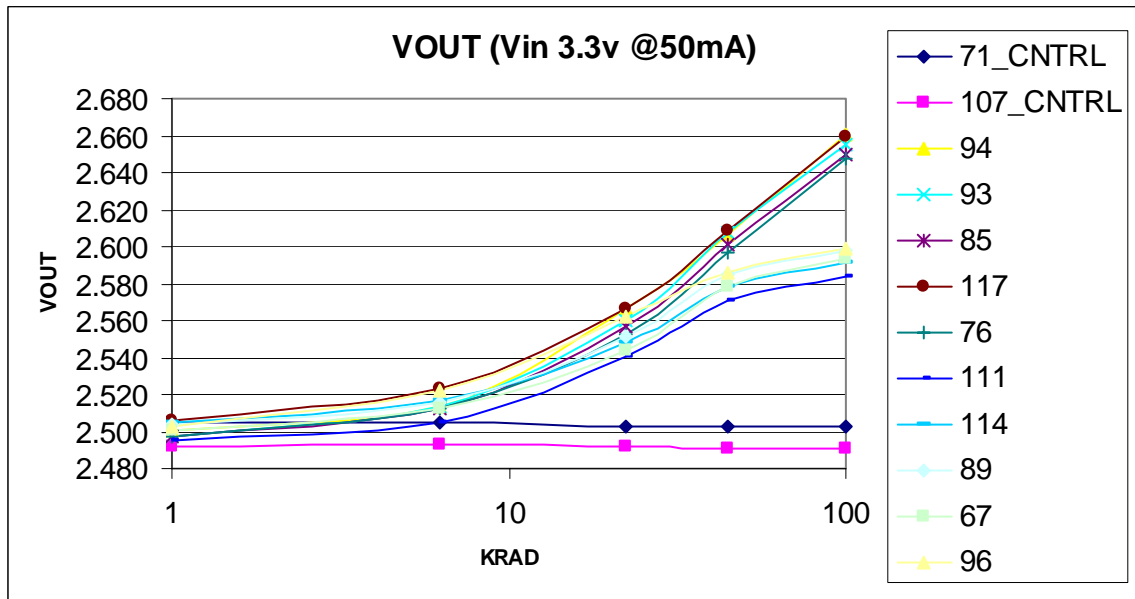


Figure 3

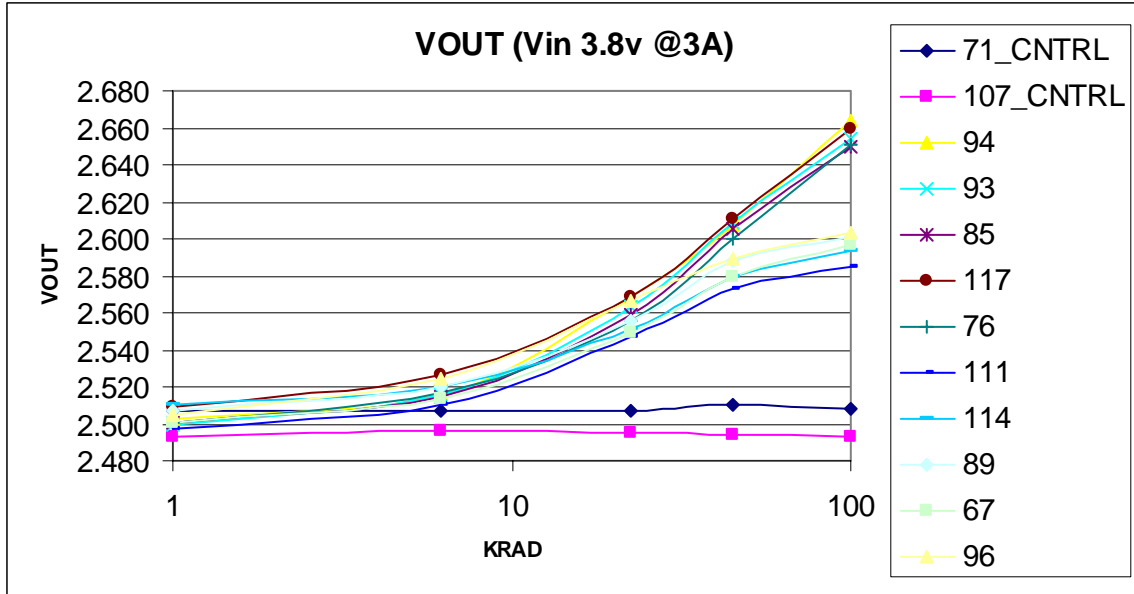


Figure 4

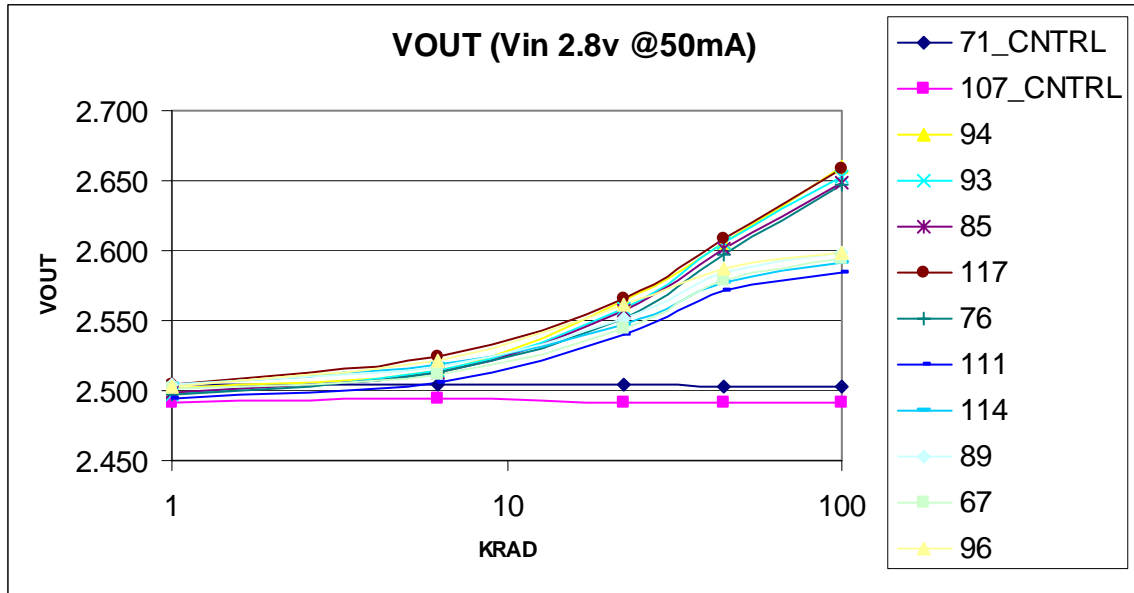


Figure 5

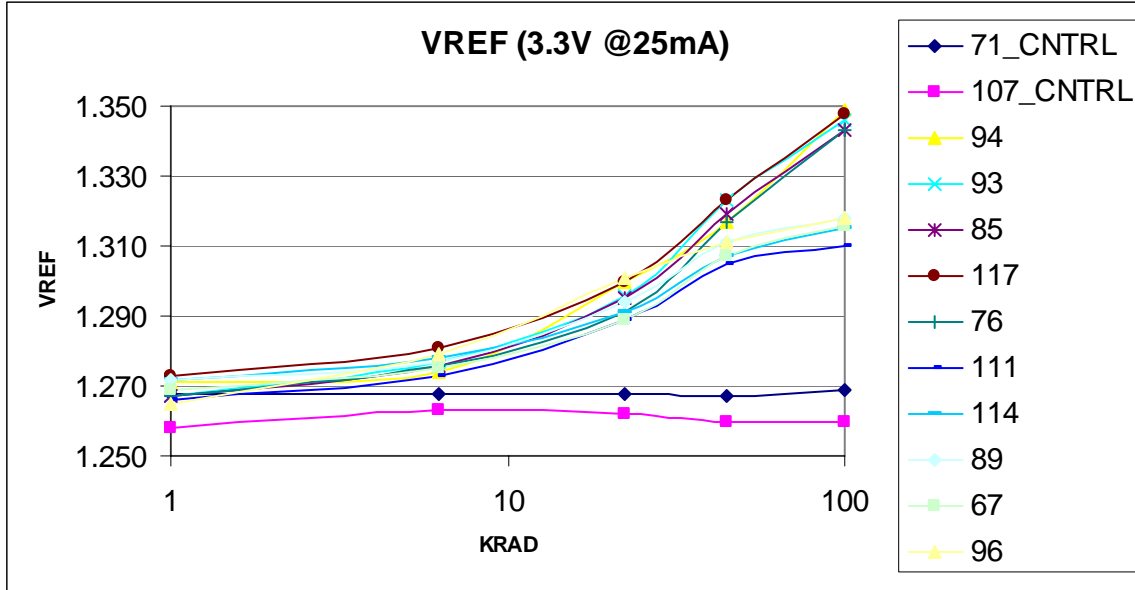
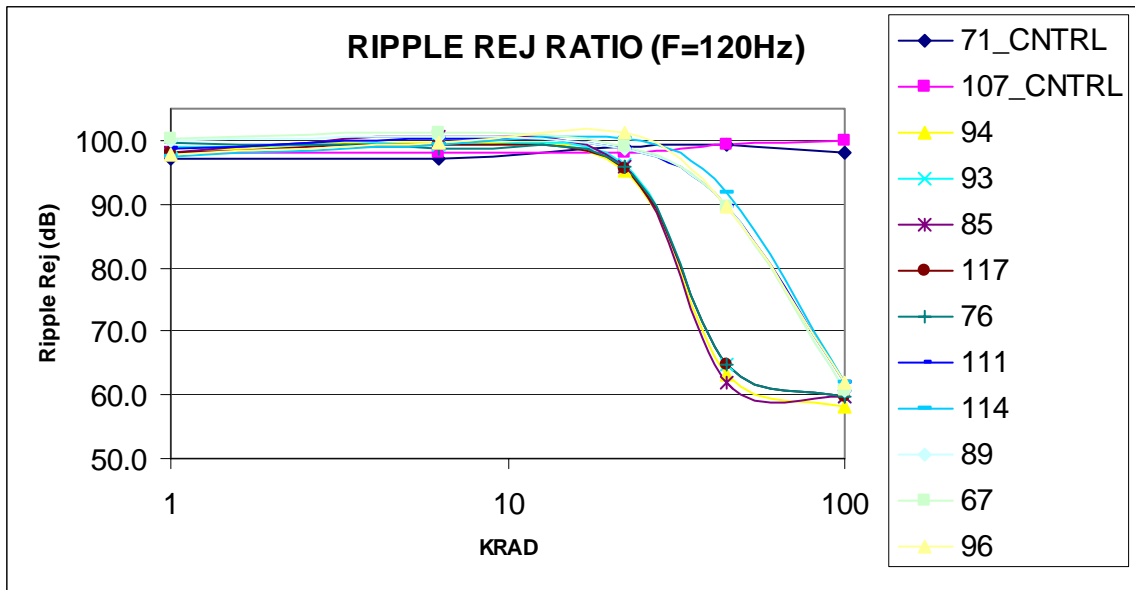


Figure 6



CONCLUSION

The IRUH33PA13B20K has demonstrated hardness to ELDRS radiation exposure up to 44.6 KRAD(Si) at dose rate of 0.065 Rad (Si)/sec with no parametric failures when device is in the "ON" or "OFF" bias condition and the results show it to meet all the post radiation test requirements. There are parametric shifts for Output Voltage, Dropout Voltage, Ripple Rejection, and Shutdown Threshold Voltage, which need to be considered in designs where tight tolerances over the life of the product need to be maintained.

Appendix A

Electrical Data

Electrical Test Data (Pre-radiation)

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Line Reg	Load Reg	Vdrop	Current Limit	Ripple Rej.	Vshdn	Vout @shdn	Ishdn*
Max Limit	2.525	2.625	2.625	2.625	2.625	6.25	73.8	0.4	10	200	1.6	100	----
Min Limit	2.475	2.375	2.375	2.375	2.375	-6.25	-73.8	0	3	65	1.0	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(uA)
71	2.510	2.505	2.507	2.504	1.268	-0.678	4.370	0.201	9.152	97.18	1.378	-1.967	0.151
107	2.494	2.492	2.493	2.492	1.258	0.181	4.541	0.193	8.907	98.18	1.319	-1.059	0.147
94	2.505	2.501	2.503	2.502	1.271	-1.718	3.237	0.195	8.658	98.06	1.319	-1.033	0.145
93	2.499	2.497	2.500	2.497	1.267	-0.407	2.402	0.192	8.749	99.15	1.339	-1.133	0.145
85	2.500	2.497	2.501	2.498	1.267	-0.407	4.260	0.210	8.477	98.06	1.319	-1.119	0.144
117	2.510	2.506	2.509	2.505	1.273	0.090	2.834	0.203	8.885	98.10	1.339	-0.975	0.151
76	2.499	2.497	2.501	2.497	1.267	-0.904	4.157	0.195	8.477	99.74	1.319	-1.018	0.149
111	2.497	2.495	2.497	2.494	1.266	0.045	3.010	0.195	8.840	98.58	1.339	-1.248	0.146
114	2.509	2.505	2.510	2.505	1.272	-0.542	4.206	0.199	8.840	97.60	1.360	-1.578	0.150
89	2.506	2.504	2.507	2.505	1.272	0.090	3.547	0.192	8.795	99.83	1.360	-1.535	0.145
67	2.503	2.501	2.501	2.501	1.269	-0.136	2.428	0.192	9.112	100.40	1.319	-2.338	0.151
96	2.506	2.503	2.505	2.503	1.265	-0.949	3.199	0.197	8.862	97.64	1.340	-1.332	0.146

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 6K RAD(Si))

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Line Reg	Load Reg	Vdrop	Current Limit	Ripple Rej.	Vshdn	Vout @shdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	65	1.0	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(uA)
71	2.510	2.505	2.507	2.504	1.268	-0.677	4.37	0.201	9.152	97.18	1.378	-1.967	0.1514
107	2.495	2.493	2.496	2.494	1.263	-0.225	4.297	0.189	9.198	98.14	1.336	-1.034	0.146
94	2.516	2.513	2.516	2.514	1.274	-1.31	4.468	0.204	8.790	99.79	1.378	-1.034	0.1427
93	2.517	2.514	2.516	2.514	1.277	-0.993	4.023	0.204	8.845	99.23	1.338	-1.277	0.1474
85	2.514	2.512	2.515	2.513	1.276	-0.722	2.932	0.223	8.481	100.50	1.359	-1.233	0.1413
117	2.529	2.523	2.526	2.524	1.281	-0.406	3.008	0.219	9.072	99.19	1.401	-0.557	0.1464
76	2.515	2.512	2.517	2.513	1.276	0.1355	4.805	0.208	9.117	98.63	1.359	-2.111	0.1435
111	2.510	2.505	2.510	2.506	1.273	-0.180	3.21	0.212	9.072	100.40	1.359	-2.212	0.1444
114	2.520	2.517	2.520	2.519	1.278	0.6777	5.719	0.212	9.072	99.23	1.380	-2.457	0.1462
89	2.520	2.516	2.520	2.517	1.277	-0.180	3.026	0.197	9.117	100.50	1.380	-0.859	0.1445
67	2.515	2.512	2.514	2.512	1.275	0.3614	3.396	0.208	9.026	101.20	1.338	-2.338	0.1512
96	2.524	2.522	2.524	2.522	1.279	0.4969	2.368	0.204	8.845	99.79	1.380	-1.332	0.1461

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 22K RAD(Si))

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Line Reg	Load Reg	Vdrop	Current Limit	Ripple Rej.	Vshdn	Vout @shdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1.0	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(uA)
71	2.505	2.503	2.507	2.504	1.268	0.4516	4.534	0.189	9.207	99.150	1.369	-1.565	0.149
107	2.495	2.492	2.495	2.491	1.262	-0.541	3.915	0.189	9.252	98.150	1.306	-1.738	0.1488
94	2.569	2.566	2.569	2.565	1.300	-0.541	4.025	0.223	8.844	95.110	1.474	-2.227	0.1388
93	2.563	2.560	2.563	2.558	1.296	-0.271	3.761	0.219	9.071	96.310	1.453	-3.149	0.1399
85	2.561	2.557	2.559	2.557	1.295	0	3.208	0.230	8.798	95.870	1.432	-3.351	0.1387
117	2.570	2.567	2.569	2.566	1.300	0.7226	3.438	0.223	9.116	95.520	1.474	-3.235	0.1433
76	2.556	2.552	2.556	2.551	1.291	-0.180	4.166	0.215	9.071	95.910	1.411	-3.423	0.1417
111	2.545	2.541	2.547	2.540	1.289	0	5.714	0.215	9.252	98.630	1.453	-0.686	0.1367
114	2.550	2.548	2.551	2.547	1.291	0.6774	2.704	0.219	9.252	100.400	1.453	-1.162	0.1419
89	2.554	2.551	2.556	2.552	1.294	0.271	4.518	0.215	9.252	98.670	1.453	-1.867	0.1386
67	2.549	2.544	2.549	2.545	1.289	0.4968	2.37	0.219	8.935	99.150	1.432	-1.507	0.1393
96	2.566	2.562	2.566	2.562	1.301	0.6774	4.78	0.215	9.113	101.100	1.505	-2.602	0.1421

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 44K RAD(Si))

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Line Reg	Load Reg	Vdrop	Current Limit	Ripple Rej.	Vshdn	Vout @shdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1.0	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(uA)
71	2.508	2.503	2.510	2.503	1.267	-0.0903	7.459	0.189	9.134	99.240	1.352	-0.982	0.1478
107	2.493	2.491	2.494	2.491	1.260	-0.0903	3.813	0.186	9.089	99.240	1.352	-1.73	0.1458
94	2.608	2.606	2.608	2.606	1.317	1.265	2.861	0.223	9.089	63.290	1.499	-1.241	0.1384
93	2.610	2.608	2.609	2.606	1.323	-0.0452	2.134	0.234	9.459	64.860	1.488	-1.942	0.1406
85	2.604	2.601	2.605	2.601	1.319	2.169	3.323	0.249	8.505	61.900	1.468	-2.072	0.1381
117	2.612	2.609	2.611	2.609	1.323	0	1.983	0.238	9.050	64.820	1.488	-3.31	0.1411
76	2.600	2.597	2.600	2.597	1.317	0.6327	3.439	0.238	9.095	64.860	1.447	-2.417	0.1409
111	2.572	2.571	2.573	2.571	1.305	0.4972	1.604	0.234	9.050	89.450	1.509	-2.417	0.1376
114	2.579	2.578	2.579	2.577	1.307	1.085	1.54	0.227	8.868	91.820	1.468	-3.152	0.1395
89	2.588	2.585	2.588	2.584	1.311	-0.2712	2.311	0.227	9.050	89.450	1.509	-3.282	0.1361
67	2.580	2.578	2.580	2.578	1.307	0.0452	1.783	0.234	8.868	89.640	1.447	-3.742	0.1356
96	2.588	2.586	2.589	2.587	1.311	0.4972	2.485	0.231	9.095	89.490	1.530	-4.074	0.1369

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 100K RAD(Si))

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Line Reg	Load Reg	Vdrop	Current Limit	Ripple Rej.	Vshdn	Vout @shdn	Ishdn*
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(uA)
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1.0	-100	----
71	2.509	2.503	2.508	2.503	1.269	0	5.659	0.197	8.855	98.150	1.357	-2.027	0.1499
107	2.492	2.491	2.493	2.491	1.260	0	4.497	0.189	9.127	99.830	1.357	-0.719	0.1475
94	2.665	2.661	2.664	2.660	1.349	-0.677	0.7832	0.254	9.101	58.020	1.465	-2.405	0.1455
93	2.655	2.655	2.654	2.653	1.346	1.401	0.467	0.254	8.829	59.670	1.465	-0.836	0.1408
85	2.651	2.650	2.650	2.649	1.343	0.4518	0.7231	0.232	8.511	59.720	1.444	-1.225	0.1418
117	2.661	2.659	2.660	2.658	1.348	-0.858	2.436	0.265	8.874	59.720	1.465	-2.045	0.145
76	2.651	2.648	2.651	2.647	1.343	1.446	1.91	0.254	8.874	59.720	1.444	-2.75	0.1435
111	2.587	2.584	2.585	2.584	1.310	1.129	2.896	0.243	8.829	61.940	1.527	-1.542	0.1346
114	2.595	2.591	2.594	2.592	1.315	0.2259	3.316	0.243	8.874	61.900	1.527	-2.16	0.1359
89	2.601	2.598	2.601	2.598	1.318	-0.677	3.027	0.239	8.874	60.740	1.527	-2.074	0.1332
67	2.597	2.593	2.597	2.594	1.316	-0.632	3.856	0.250	8.511	60.780	1.507	-4.059	0.1339
96	2.602	2.599	2.603	2.599	1.318	0.5421	4.724	0.247	8.829	61.94	1.548	-2.376	0.1338

* Data collected for information purposes only parameter not specified for pre-radiation.

Appendix B

Radiation Test Specification

Specification #	T090104G	Revision: A	ECN #	Date:
IR Base Part No.	IRRUH33PA13B20K			

PRODUCT DISCIPTION: ADJUSTABLE LOW DROPOUT VOLTAGE REGULATOR

Automatic Test Tester: PXI TEST CONSOLE 04-134-TC

Table 1: Pre Radiation Tests, 25C tests only ¹

Prog. Ref.	Test	Symbol	Test Conditions	Rad Level:	Notes	MIN	MAX	Units
A	Output Voltage	V out	Vin = 3.30 Vdc	Pre Rad		2.475	2.525	Vdc
			Iout = 1.5 A					
A	Output Voltage	V out	Vin = 3.3 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V out	Vin = 3.8 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
A	Output Voltage	V out	Vin = 2.8 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V ref	Vin = 3.3 Vdc	Pre Rad		1.225	1.305	Vdc
			Iout = 25mA					
A	Line Regulation	Vrline	2.9V < Vin < 3.8V	Pre Rad		-6.25	6.25	mVdc
			Iout = 50 mA					
A	Load Regulation	Vrload	Vin = 3.3V	Pre Rad		-73.8	73.8	mVdc
			50mA < Io < 3.0A					
A	Dropout Voltage	Vdrop	Iout = 3A	Pre Rad		0	0.40	Vdc
A	Current Limit	I limit	Vin = 3.3 Vdc	Pre Rad		3.0	10.0	A
A	Ripple Rejection	Rrej	F= 120 Hz	Pre Rad		65	200	dB
			Iout = 50 mA					
A	Shutdown Threshold	Vshutdown	Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to 4.8V, output monitored for 100mV drop below	Pre Rad		1.0	1.6	V
A	Output voltage At Shutdown	Vout shdn	Vin = 3.3 Vdc	Pre Rad		-0.1	+0.1	V
			Iout = 50 mA					
			Vshdn = +5 Vdc					
A	Shutdown Pin Current	Ishutdown	Vin = 3.3 Vdc	Pre Rad	2	---	---	uA
			Iout = 50 mA					
			Vshdn = +5 Vdc					

Notes:

1. Regulator shall be biased at a nominal Vout of 2.5V with Radjust set at 976 ohms and tested to the limits specified on the data sheet.
2. These tests are performed for information purposes only.

This is proprietary information of International Rectifier Hi-Rel Products and it is understood that this will not be divulged to a third party or used in any way prejudicial to the interest of International Rectifier Hi-Rel Products.

Automatic Test		Tester: PXI TEST CONSOLE 04-134-TC						
Table 2: Post Radiation Tests, 25C tests only ¹								
Prog. Ref.	Test	Symbol	Test Conditions	Rad Level:	Notes	MIN	MAX	Units
B	Output Voltage	V out	Vin = 3.30 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 1.5 A					
B	Output Voltage	V out	Vin = 3.3 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 50 mA					
B	Output Voltage	V out	Vin = 3.8 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
B	Output Voltage	V out	Vin = 2.8 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 50 mA					
B	Output Voltage	V ref	Vin = 3.3 Vdc	Post Rad		1.202	1.328	Vdc
			Iout = 25mA					
B	Line Regulation	Vrline	2.9V < Vin < 3.8V	Post Rad		-12.5	12.5	mVdc
			Iout = 50 mA					
B	Load Regulation	Vrload	Vin = 3.3V	Post Rad		-147.6	147.6	mVdc
			50mA < Io < 3.0A					
B	Dropout Voltage	Vdrop	Iout = 3A	Post Rad		0	0.40	Vdc
B	Current Limit	I limit	Vin = 3.3 Vdc	Post Rad		3.0	10.0	A
B	Ripple Rejection	Rrej	F= 120 Hz	Post Rad		40	200	dB
			Iout = 50 mA					
B	Shutdown Threshold	Vshutdown	Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to 4.8V, output	Post Rad		1.0	1.7	V
B	Output voltage At Shutdown	Vout shdn	Vin = 3.3 Vdc	Post Rad		-0.1	+0.1	V
			Iout = 50 mA					
			Vshdn = +5 Vdc					
B	Shutdown Pin Current	Ishutdown	Vin = 3.3 Vdc	Post Rad	2	---	---	uA
			Iout = 50 mA					
			Vshdn = +5 Vdc					

Notes:

1. Regulator shall be biased at a nominal Vout of 2.5V with Radjust set at 976 ohms and tested to the limits specified on the data sheet.
2. These tests are performed for information purposes only.

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Table 3: Total Dose Radiation Requirements

High Dose Rate ³		
Bias Conditions	Vin = 6.8V, Vout = 2.5V, Io=10mA	Unbiased, in circuit with power supply off
Dose Step Profile	30K, 20K, 50K, 50K, 50K	30K, 20K, 50K, 50K, 50K
Dose Rate Range	50 to 300 Rad(Si)/sec	50 to 300 Rad(Si)/sec
Board Number	TF-02-011	TF-02-011
Program Card Number	05-043-TA	05-043-TA
Chamber	Gamma Cave	Gamma Cave
Test Temperature	25C +/-5C	25C +/-5C
Low Dose Rate ³		
Bias Conditions	Vin = 6.8V, Vout = 2.5V, Io=10mA	Unbiased, in circuit with power supply off
Dose Step Profile	30K, 20K, 50K, 50K, 50K	30K, 20K, 50K, 50K, 50K
Dose Rate Range	0.01 to 0.10 Rad(Si)/sec	0.01 to 0.10 Rad(Si)/sec
Board Number	TF-02-008	TF-02-008
Program Card Number	05-043-TA	05-043-TA
Chamber	Hot Cell	Hot Cell
Test Temperature	25C +/-5C	25C +/-5C

3. Performed at during initial qualification of the device and retested only when specified by Quality Assurance due to a change per MIL-PRF-38534.

Radiation Circuit

